Chapter 2
General Considerations

2-1. Introduction

Although it is impossible to quantify the overall safety of a dam, the way to achieve maximum dam safety is well understood, i.e., to apply the utmost care and competence to every aspect of design, construction, operation, and maintenance. Therefore, the most important prerequisite for safety of dams is the professional competence of persons associated with the dam over its life span. A dam with a record of safe performance may still experience failure due to undetected deficiencies in the dam or in the foundation. Dam safety must take precedence over all other considerations (International Commission on Large Dams 1987; National Research Council 1985; Jansen 1983, 1988b).

2-2. History of Dam Safety

a. *Early development of dams.* History indicates that dams have been a vital part of civilization for more than 5,000 years. Dams were constructed by the early settlers in the United States in the 1600's to provide water supply and power gristmills and sawmills. The oldest Corps of Engineers dams are six lock and dams on the Green and Kentucky Rivers built between 1836 and 1844 (Reed 1987, Walz 1990a).

b. Dam safety. Although construction of dams dates back many years, the history of dam safety covers a much shorter time span. Only a limited number of states had any type of law regulating dam safety prior to 1900. The failure of the South Fork Dam at Johnstown, Pennsylvania, in 1889 resulting in 2,209 deaths had limited influence on the dam safety programs. California initiated a dam safety program following failure of the St. Frances Dam in 1928. Failures of the Buffalo Creek Dam in West Virginia and the Canyon Lake Dam in South Dakota in 1972 contributed to Congress passing "The National Dam Inspection Act" in 1972. Failure of Teton Dam in Idaho in 1976 was followed by "The Reclamation Safety of Dams Act" in 1977. Failure of the Laurel Run Dam in Pennsylvania and the Kelly Barnes Dam in Georgia in 1977 set in motion the development of the "Federal Guidelines for Dam Safety" issued in 1979 by the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) (discussed in paragraph 2-3) (Federal Emergency Management Agency 1979). In 1979, President Carter created the Federal Emergency Management Agency (FEMA) and directed Federal agencies to adopt and implement the Federal Guidelines for Dam Safety and report their progress to FEMA on a biennial basis. In 1980, the Interagency Committee on Dam Safety (ICODS) was formed to coordinate Federal activities and work with the states to ensure implementation of dam safety practices. The Corps of Engineers is the Department of Defense representative on ICODS. In 1984, the Association of State Dam Safety Officials (ASDSO) was organized to provide a forum for the exchange of information and ideas on dam safety and to foster interstate cooperation (Association of State Dam Safety Officials 1989). Nongovernment agencies actively dealing with dam safety include the International Commission on Large Dams (ICOLD) and its United States affiliate, the United States Committee on Large Dams (USCOLD) and the Electric Power Research Institute (EPRI) (Colorado Division of Disaster Emergency Services 1987; Tschantz 1982; Reed 1987; Walz 1990a; Wiseman 1987; Jansen 1988a; Government Accounting Office 1977, 1978; Duscha 1984, 1986, 1990).

2-3. Federal Guidelines for Dam Safety

a. In 1977, President Carter issued a memorandum directing three actions:

(1) That all Federal agencies having responsibility for dams conduct a thorough review of their practices which could affect the safety of these structures and report their findings to the FCCSET.

(2) That FCCSET prepare the "Federal Guidelines for Dam Safety" for use by all Federal agencies.

(3) That ICODS be established to promote and monitor Federal and state dam safety programs.

b. In 1979, the "Federal Guidelines for Dam Safety" was published, and ICODS was given oversight

responsibility for dam safety. The key management practices outlined in these guidelines are as follows (Federal Emergency Management Agency 1979):

(1) Establish a Dam Safety Officer and appropriate staff.

(2) Maintain an updated inventory of dams.

(3) Document design criteria and construction activities.

(4) Prepare initial reservoir filling plans and reservoir regulation criteria.

(5) Prepare operation and maintenance instructions and document activities.

(6) Maintain a training and awareness program.

(7) Prepare and maintain EAPs for each dam.

(8) Establish a program of periodic inspections and evaluation of dams.

(9) Monitor and evaluate the performance of each dam and appurtenant structure and provide remedial construction as necessary.

2-4. Administration of Dam Safety in the Corps of Engineers

a. Dam safety at HQUSACE. In February 1980, the Chief of Engineers appointed the Chief of Engineering Division, Directorate of Civil Works, as the HQUSACE Dam Safety Officer. The Dam Safety Officer chairs a standing committee composed of individuals having assigned responsibilities for dam safety (ER 1110-2-1156). The Corps' Dam Safety Officer is also the Corps' member of FEMA's ICODS (Federal Emergency Management Agency 1988b).

b. Dam safety organization. The Corps of Engineers maintains a decentralized organization of three levels. Each level is staffed with qualified and experienced personnel in areas of design, construction, and operations of dams and appurtenant structures. Each level has a Dam Safety Officer and organization as follows (ER 1110-2-1156):

(1) HQUSACE.

(a) Organization. The standing dam safety committee members are as follows:

- Chief, Engineering Division, Directorate of Civil Works, Chairman.
- Chief, Engineering Division, Directorate of Military Programs.
- Chief, Operations, Construction and Readiness Division, Directorate of Civil Works.
- Chief, Geotechnical and Materials Branch, Engineering Division, Directorate of Civil Works.
- Chief, Hydraulics and Hydrology Branch, Engineering Division, Directorate of Civil Works.
- Chief, Structures Branch, Engineering Division, Directorate of Civil Works.
- Chief, Electrical and Mechanical Branch, Engineering Division, Directorate of Civil Works.
- Chief, Construction Branch, Operations, Construction and Readiness Division, Directorate of Civil Works.
- Chief, Policy Development Branch, Policy Review and Analysis Division, Directorate of Civil Works.

(b) Responsibilities. The Dam Safety Officer is responsible for ensuring that the Corps of Engineers maintains a proactive dam safety program and is implementing the Federal Guidelines for Dam Safety (Federal Emergency Management Agency 1979) in policy and practice and other duties as described in ER 1110-2-1156. The committee periodically reviews and evaluates design, construction, operation, maintenance, and rehabilitation programs to improve internal practices

related to dam safety; reviews the status of EAPs and dam safety training; and reviews research and development programs to ensure that the latest technology receives consideration and evaluation. The committee meets at least semi-annually and makes periodic inspections and field visits as necessary. The committee ensures that the inventory of dams is current and adequately maintained and reviews research and development programs to ensure that the latest technologies related to dam safety receive consideration and evaluation (ER 1110-2-1156).

(2) Major Subordinate Commands (MSC).

(a) Organization. The MSC Dam Safety Officer is the Director of Engineering and Technical Services. The standing committee contains the chiefs of the same disciplines as that in HQUSACE.

(b) Responsibilities. The MSC Dam Safety Officer and committee are responsible for quality assurance coordination and implementation of the dam safety program within the MSC. The committee will conduct a minimum of two meetings per year. Their responsibilities include establishing dam safety related work priorities within the MSC, monitoring the status of EAPs, ensuring dam safety training is being conducted, ensuring that adequate data are submitted for the inventory of Corps dams, and conducting dam safety exercises (see ER 1110-2-1156).

(3) District Commands.

(a) Organization. The District Dam Safety Officer will be the Chief, Engineering Division. The standing committee will comprise the same disciplines as that in the MSC. However, the Dam Safety Officer may be located in a district responsible for the technical aspects of projects located within another districts boundaries (should a district organization not include an engineering division).

(b) Responsibilities. The District Dam Safety Officer and committee are responsible for the execution of the dam safety program. A minimum of two meetings will be held annually. Responsibilities include establishing a public awareness program with information at each project and coordination with downstream local interests, monitoring and evaluating the performance of all dams and appurtenant structures

and recommending remedial measures when necessary, establishing the priority of dam safety related work, conducting dam safety training, and ensuring that each dam has an adequate surveillance plan (ER 1110-2-1156).

2-5. Applicable Dams

a. Dam involvement. The Corps of Engineers involvement in dams can be categorized as follows (ER 1110-2-1156, Federal Emergency Management Agency 1992a):

(1) Dams which the Corps has designed, constructed, operates, and maintains. Ownership remains with the Corps of Engineers.

(2) Dams which the Corps has designed and constructed but are owned, operated, and maintained by others.

(3) Dams that are designed, constructed, operated, maintained, and owned by others in which flood control storage has been provided at Federal expense under the authority of the 1944 Flood Control Act.

(4) Dams for which the Corps has issued permits under its regulatory authority.

(5) Dams inspected and evaluated by the Corps under the authority of the National Program for the Inspection of Non-Federal Dams, PL 92-367.

b. Dam safety. In category 1, the Corps of Engineers has a definite responsibility for dam safety. For dams in category 2, the primary responsibility for dam safety is with the agency or sponsor which accepts the project. The Corps' responsibility in this case is a supporting consultant role. In category 3, the Corps should participate in inspections to ensure that the Federal flood control interest is being properly maintained. For categories 4 and 5, the Corps has no responsibility for dam safety (ER 1110-2-1156, Federal Emergency Management Agency 1992a).

2-6. Modification of Dams

a. Programs. The bulk of Corps of Engineers dams are over 30 years old, and many dams are over 60 years old. Aging structures and advances in technology impact on the safety of dams and require detailed reevaluation and, in some cases, modification. Rehabilitation of Corps of Engineers dams is accomplished through four programs (ER 1110-2-1155, ER 1130-2-417, ER 1165-2-119, Federal Emergency Management Agency 1992b, Walz 1990a):

(1) Major Rehabilitation Program. This program allows significant, costly, one-time structural rehabilitation or major replacement work. This work restores the project to its original condition to serve as originally intended. Work under the Major Rehabilitation Program includes dams, locks, powerhouses, and breakwaters (ER 1130-2-417).

(2) Dam Safety Assurance Program. This provides for modification of completed dams when deemed necessary for safety purposes due to new hydrologic or seismic data or changes in the state-of-the-art design or construction criteria. This program is under the authority of Section 1203 of the Water Resources Development Act of 1986 (PL 99-662) and permits the project to function effectively as originally intended. Examples of work under this program include enlarging existing facilities or constructing new facilities to provide for modifications resulting from new hydrologic or seismic data or changes in state-of-the art design or construction criteria deemed necessary for safety purposes.

(3) Modifications to completed projects. Completed Corps projects are observed and monitored to ascertain whether they continue to function in a satisfactory manner and whether potential exists for better serving the public interest. When it is found that changes in a completed project may be desirable, investigations are undertaken to document the need for and feasibility of project modifications. To the extent possible, modifications to completed projects are accomplished under existing authorities. Significant modifications to completed projects involving new Federal construction or real estate acquisition in order to serve new purposes, to in crease the scope of services of authorized purposes beyond that intended at the time of project construction, or to extend services to new beneficiaries, require authorization by Congress. Additional information including eligible works, local protection projects, justification and cost sharing, and multiple purpose projects is given in ER 1165-2-119.

(4) Operation and maintenance authority. To properly operate the project or minimize maintenance, reasonable changes and additions to facilities, within the project boundaries, are made as needed as part of the Corps' operations and maintenance program (ER 1165-2-119). Operation and maintenance are discussed in detail in Chapter 4.

b. Reporting sequence. Under the Major Rehabilitation and Dam Safety Assurance Programs, investigations are conducted and reports prepared to determine the need for and scope of remedial measures, and to form the basis for obtaining construction funds. Reports are followed by more detailed investigations which are reported in design memoranda. The design memoranda form the basis for preparing plans and specifications for the remedial work. More detail regarding the Major Rehabilitation and Dam Safety Assurance Programs is given in Chapter 5.

2-7. Regulatory Permit Program for Non-Federal Dams

a. Dams and dikes. Section 9 of the River and Harbor Act of March 3, 1899, charges the Chief of Engineers and the Secretary of the Army to regulate the construction of any dam or dike across any navigable water of the United States. The term "navigable waters of the United States" means those waters of the United States that are subject to the ebb and flow of the tide shoreward to the mean high water mark (mean higher high water mark on the Pacific coast) and/or those presently used or have been used in the past or may be susceptible to use to transport interstate or foreign commerce. The term "dike or dam" means any impoundment structure that completely spans a navigable water of the United States and that may obstruct interstate waterborne commerce. The term does not include weirs. Dams and dikes in navigable waters of the United States also require Department of the Army (DA) permits under Section 404 of the Clean Water Act of 1977, as amended (33 U.S.C. 1344). (U.S. Army Corps of Engineers, Office of the Chief of

Engineers 1977). Processing a DA application under Section 9 will not be completed until the approval of the United States Congress has been obtained if the navigable water of the United States is an interstate water body, or until the approval of the appropriate state legislature has been obtained if the navigable water of the United States is an intrastate water body (i.e., the navigable portion of the navigable water of the United States is solely within the boundaries of one state).

b. Dredged or fill material. Section 404 of the Federal Water Pollution Control Act Amendments of 1972 charges the Secretary of the Army, acting through the Chief of Engineers, to regulate the discharge of dredged or fill material in the waters of the United States. The construction of dams, dikes, etc., is considered to be a discharge of fill material under Section 404. On March 27, 1975, the U.S. District Court for the District of Columbia directed the Corps of Engineers to extend its responsibility to regulate the discharge of dredged or fill material under Section 404 to all waters of the United States (including territorial seas) and to revise its regulation accordingly. The term "waters of the United States" is a much broader term than "navigable waters of the United States." A final regulation was published on July 19, 1977 (U.S. Army Corps of Engineers, Office of the Chief of Engineers 1977).

c. Documentation for safety. Safety is one of the factors considered in reaching public interest decisions on applications for permits. The applicant for a permit to construct a dam is required to furnish documentation in order that the Corps may verify that the proposed dam has been designed for safety. No specific design specification or criteria are prescribed, and no independent detailed engineering reviews are performed. Further information on permit regulation and dam safety is given in Permit Regulation 33 Code of Federal Regulation 320.4(k) (U.S. Army Corps of Engineers, Office of the Chief of Engineers 1977).